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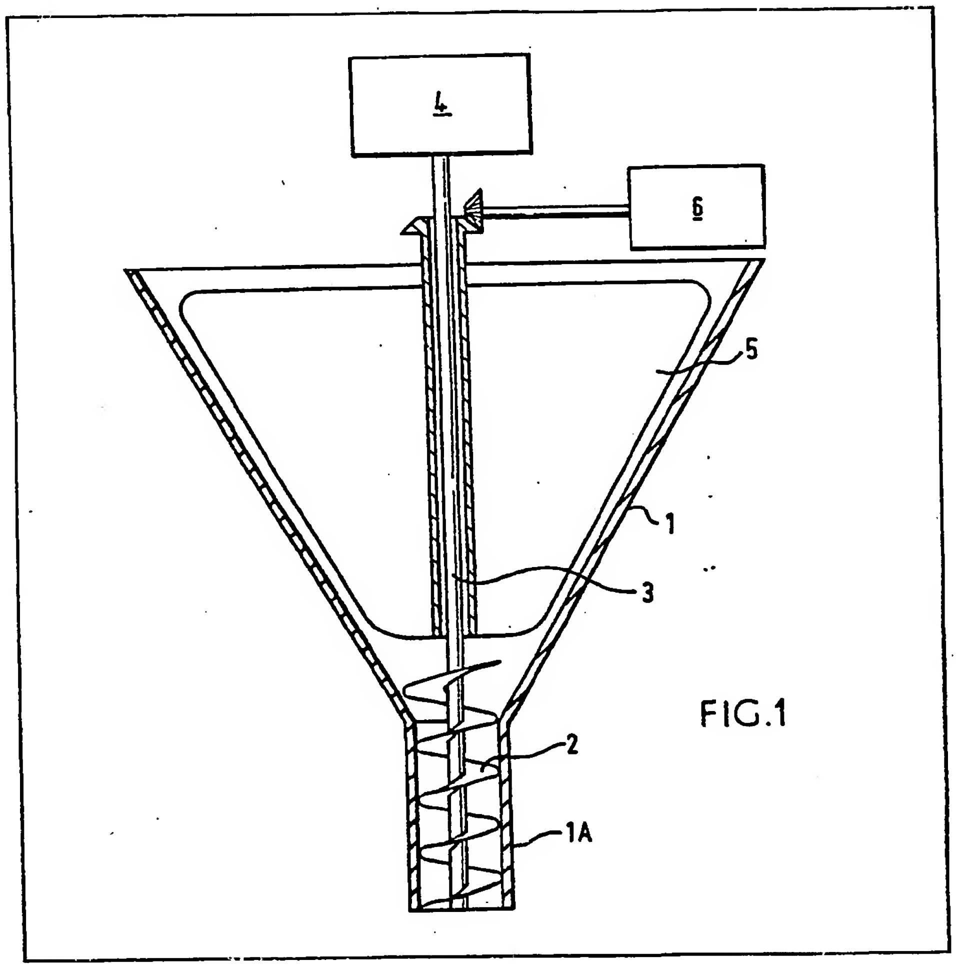
(54) Apparatus for dispensing flowable materials

(57) Apparatus for dispensing flowable materials wherein dispensing means, such as a rotating auger 2, is caused either to dispense predetermined doses of material, or a mass of material at a constant flowrate, from a hopper 1. A stepping-motor 4 is provided for controlling operation of said dispensing means. In this way either the amount of material in successive doses dispensed can be accurately controlled or control can be achieved so that the apparatus will dispense material continuously at a constant rate of mass flow.



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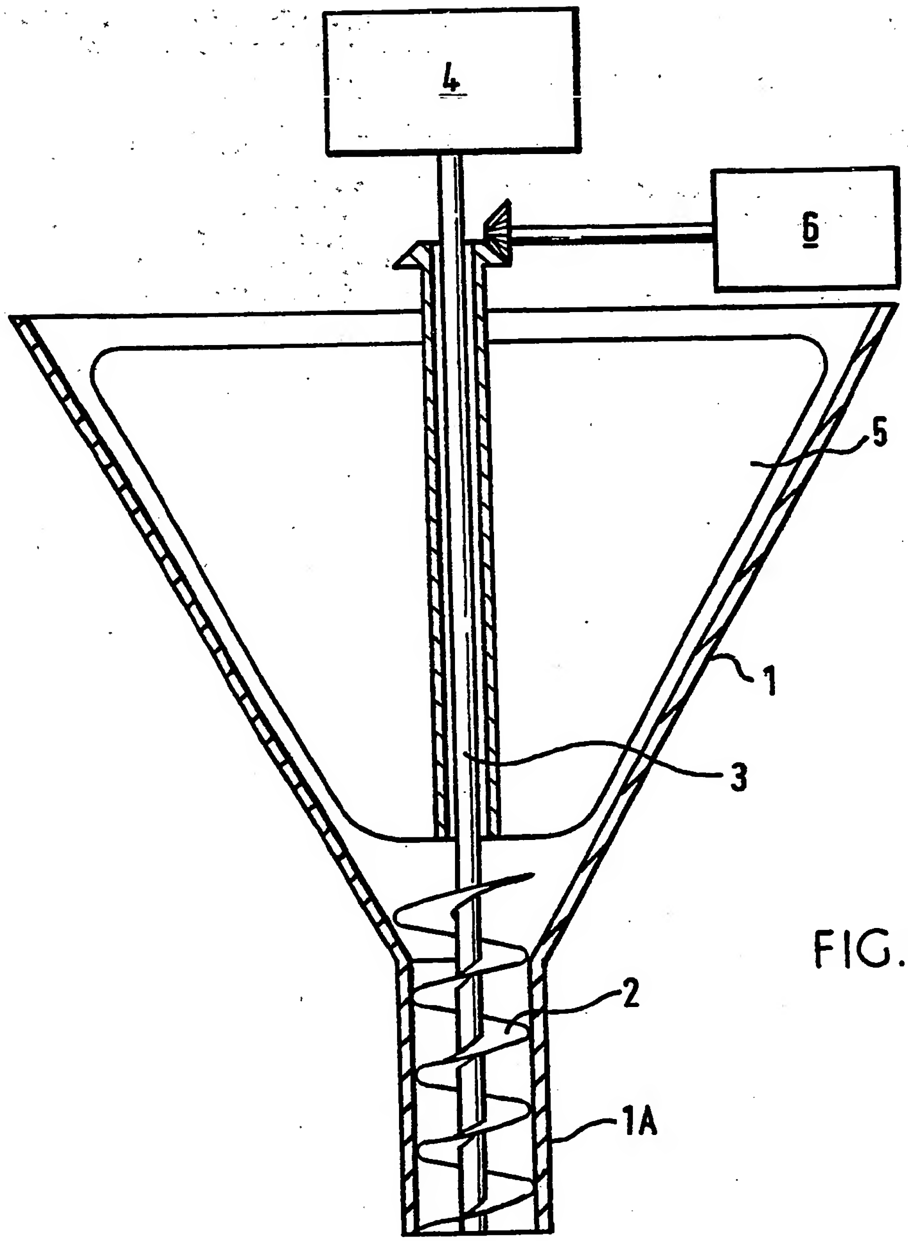
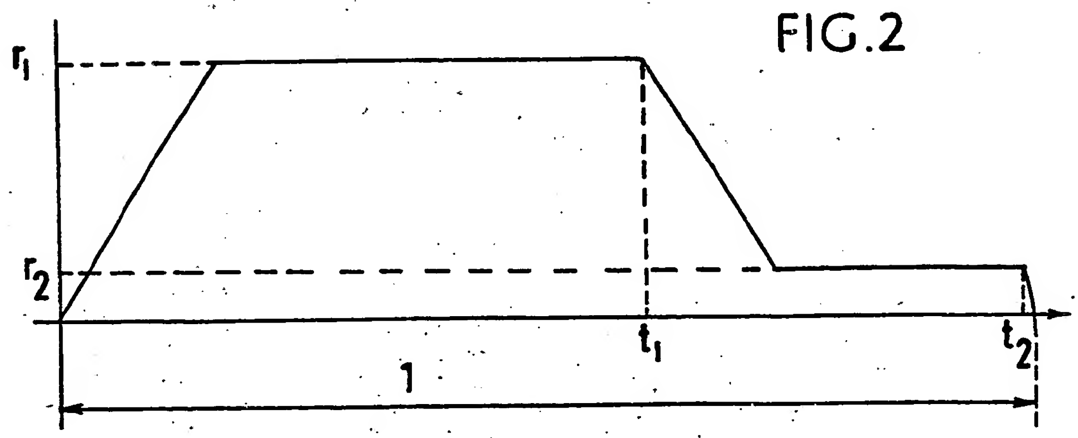


FIG.1

FIG.2



SPECIFICATION

Dispensing Apparatus for flowable materials

FIELD OF THE INVENTION

The present invention relates to dispensing apparatus for flowable materials.

BACKGROUND OF THE INVENTION

The invention is particularly concerned with the dispensing of particulate solid materials but will also find application in the dispensing of liquids and pastes. The term "particulate solid material" as used herein is intended to mean "solid material in the form of discrete elements" and it is not intended that there be any limitation to materials in which these elements, i.e. its "particles", are of small size. Thus the material may be in powder or granular form, such as flour, salt, grain, sugar, sand, plastics nibs etc., or may comprise such "particles" as carrots, potatoes, lumps of coal or other mine or quarry products, and so on, and dispensing devices of any desired size or capacity may be provided according to the invention, ranging from those capable of dispensing powders in doses of a fraction of a gram to those capable of handling mine or quarry products where rates of mass flow may be in the order of tons per second. Dispensing devices according to the invention will be useable not only with those particulate solid materials which are usually regarded as being "free-flowing", (e.g. grain, salt, granulated sugar), but also with those which have a tendancy to arch or stick, (e.g. flour or powdered sugar).

The invention is concerned with that type of apparatus wherein material is "positively" dispensed, that is to say wherein the material is not dispensed solely by gravitational discharge from a store of the material but wherein the material is driven from a store thereof to its dispensing point by a mechanism which determines the rate at which material is dispensed. In the case of particulate solid materials and pastes the mechanism usually comprises a screw helix rotatable within a cylindrical tube and referred to in the art as an auger, and in the case of liquids it comprises a positive displacement pump.

One particular problem which the invention seeks to overcome is that which is experienced with prior dispensing apparatus of the above-indicated type when required to dispense material intermittantly, in a successive series of equal doses, e.g. when packaging. Usually the auger or equivalent is driven by a constant-speed motor *via* a clutch/brake mechanism which latter is employed to effect the required intermittant operation of the dispenser. The operational signals by which the clutch/brake mechanism is controlled, and accordingly by which the quantity of material in each successive dose is determined, may be derived in various ways so that, for example, the auger or equivalent may be declutched and braked in response to a signal derived from a timer or revolution counter when it has rotated for a predetermined period of time or when it has performed a predetermined number of revolutions, or in response to a signal derived from a downstream total mass sensing device when the required mass of material as sensed thereby has been dispensed. However, whichever method is employed for determining when the clutch/brake mechanism should be actuated for each dose, it will be appreciated that consistently accurate dosing will not be achieved unless the clutch/brake mechanism can be relied upon to operate entirely consistently for each dose, and this need is particularly acute when operating at high dosing rates.

There are various factors which determine the exact manner in which the clutch/brake mechanism will operate in terms of, for example, the time taken for the clutch and brake elements to become fully engaged/disengaged and to effect acceleration of the auger or equivalent to, or deceleration thereof from, the running speed of the motor; clearly, variations in such operation will introduce corresponding variations in the amount of material dispensed irrespective of the method employed for determining the times of actuation of the clutch/brake mechanism. Of these factors perhaps the most important are the state and the operating temperature of the friction linings employed, both of which can vary quite considerably. Furthermore, it can be said that in general the higher the dosing rate the greater will be the inconsistencies in operation of the clutch/brake mechanism caused by such variations whereas, as indicated above, it is in these circumstances of operation that the greatest consistency is needed. It will also be appreciated that the existence of a clutch/brake mechanism adds substantially to the inertia of the drive for the auger or equivalent, and this in itself is an impediment to satisfactory operation at high dosing rates.

Thus, the employment of a clutch/brake mechanism as described above is both expensive and effectively limits the rate at which consistently accurate dosing can be achieved and, of course, the fact that a clutch/brake mechanism necessarily requires a certain non-neglicable period of time to operate at all imposes a limitation upon the rate at which even approximate dosing can be achieved.

SUMMARY OF THE INVENTION

Broadly stated the present invention resides in dispensing apparatus for flowable materials wherein, in operation, material is "positively" dispensed by a mechanism, (i.e. auger, positive displacement pump or equivalent), which is driven by a so-called stepping motor, (or electromagnetic rotary incremental actuator). The stepping motor is a device which accurately converts a digital electrical input to a corresponding stepwise rotary shaft-motion output and, as such, by closely controlling the nature of the electrical input to the motor its rotary output can be correspondingly accurately controlled as to, for example, the total number of revolutions or fractions of revolutions performed in a given phase of operation, its running speed and acceleration/deceleration. In other words, the stepping motor is an eminently "programmable" device. In the context of

dose dispensing of flowable materials it can be arranged to operate an auger or equivalent with great consistency throughout each successive dose, and avoiding the need to employ the clutch/brake mechanism of the prior art. Nevertheless, it is within the scope of the invention to employ additional braking means for the motor should the need arise, (for example should the non-energized holding torque of a motor be insufficient in a particular application).

Another context in which the employment of apparatus according to the invention is believed to be particularly advantageous is when it is required to dispense material continuously at a constant rate of mass flow. Such constancy is often difficult to achieve with prior art dispensers as it may require continual adjustment of the rotational speed of the auger or equivalent in response to variations in the bulk density of the material being dispensed; in the case of particulate solid materials such variations can be quite considerable. However, quick-reaction speed control of a stepping motor can be provided for without difficulty.

It is, however, not only in the context of dose dispensing and constant mass flowrate dispensing that apparatus according to the invention will find application, and nothing in this Specification is to be taken as implying that such apparatus is limited to use in these particular dispensing processes.

BRIEF DESCRIPTION OF THE DRAWINGS

An exemplary embodiment of the invention will now be more particularly described with reference to Figures 1 and 2 of the accompanying drawings, which shows the apparatus partly in section and partly schematically.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

In Figure 1, reference numeral 1 denotes a hopper for particulate solid material which is continued downwards at 1A as a cylindrical tube to, together with a screw 2, define an auger. The screw 2 is connected by a drive shaft 3 to a stepping motor 4. Coaxial with shaft 3 is a conventional agitator 5 for the material in the hopper, which is driven independently of the auger means of a second motor 6, (e.g. a synchronous electric motor), although in certain cases it is quite practicable for an agitator to be driven by the stepping motor which drives the auger, either at the same speed as the auger or at a reduced speed *via* a suitable gearbox. Details of the various shaft bearings, motor mounts etc., are omitted from the drawing. When the apparatus is used as a dose dispenser the stepping motor 4 may simply be programmed to perform a given number of revolutions for each successive dose, following a predetermined phase of acceleration and deceleration at the beginning and end of each dose. The motor can be depended upon to follow the same sequence consistently for each dose and provided that the material within the hopper is of sufficient homogeneity each dose of material dispensed will accordingly be of equal quantity.

If the latter condition is not met, and particularly if the apparatus is being used as a constant mass flowrate dispenser, it is necessary to employ a means of sensing the total mass or the mass flowrate of dispensed material from which the motor 4 can be controlled; that is to say the motor will be stopped in response to a signal derived from a total mass sensor, (e.g. a mass flowrate sensor of which the output is integrated or a dead-weight scale associated with the receptacle into which the material is dispensed), when the correct quantity of material for a dose has been dispensed, or the speed of the motor will be controlled in response to a signal derived from a mass flowrate sensor in order to maintain the mass flowrate of dispensed material constant, as appropriate. It is particularly preferred that such a mass flowrate sensor comprises that which is disclosed in our co-pending United Kingdom Patent Application No. 25384/73 (Serial No. 1,427,774) or No. 47451/75. In such a case the arrangement might be as shown in Figures 1 or 2 of the Complete Specification of Application No. 25384/73 or as shown in Figures 1 or 2 of the Provisional Specification of Application No. 47451/75 with dispensing apparatus according to the present invention constituting the feeding device 2 of those Figures and supplying material to the rotary or vibratory element 3 of those Figures.

When the motor 4 is being controlled in response to a total mass sensor in order to determine the quantity of material in successive dispensed doses it is believed to be advantageous for each dose to comprise a two-stage process as indicated in Figure 2. Thus for each dose the motor is first accelerated at a predetermined rate to a predetermined speed r_1 at which it runs until time t_1, at which point it is decelerated, again at a predetermined rate, to a second predetermined speed r_2. Time t_1 is the time at which a signal is received from the total mass sensor representing that a relatively high predetermined percentage of the desired total mass has been dispensed. The motor then continues to run at speed r_2 until time t_2, at which point it is decelerated at a predetermined rate to rest. Time t_2 is the time at which a signal is received from the total mass sensor representing that a second percentage of the desired total mass has been dispensed, the latter percentage being so related to the rate of deceleration from speed r_2 that when the motor finally comes to rest the desired total mass of material will have been dispensed. Such a process enables high dosing rates to be achieved by virtue of the initial stage of operation at the relatively high speed r_1, and at the same time enables very accurate dosing to be achieved by virtue of the final stage of operation at the relatively low speed r_2; it will be appreciated that the lower the speed r_2 the smaller will be any errors introduced by virtue of the response time of the total mass sensor and the smaller will be the amount of material in transit between the auger and the sensor at the moment when the auger is stopped.

In an alternative two-stage process employing the apparatus of Figure 1 the time for which the auger runs at the high speed r_1 is determined not by a total

mass sensor but is calculated to be that required for a relatively high percentage of the desired total mass to be dispensed and the signal at t_1 which initiates deceleration to speed r_2 is derived from a timer or a revolution counter; the signal at time t_2 is, however, derived from a total mass sensor as in the previously described process. Thus in this process the major portion of a dose is in effect metered volumetrically and then "topped-up" by weight, whereas in the previously described process both stages of operation are weight-controlled.

It is also envisaged to provide a double-dispenser system wherein a first auger is driven by, say, a synchronous electric motor to deliver the major portion of a dose volumentrically, and a second auger driven by a stepping motor is employed to "top-up" the dose to the required amount in response to a total mass sensor.

Weight-control systems other than mass flow sensing may be used in conjunction with the stepping-motor 4. One such system may consist of a weighing scale or load cell which is placed under the container being filled with dispensed material and which is adapted to provide a signal to stop the stepping-motor when a correct weight has been dispensed.

In this system the stepping motor 4 may run at a single speed and receive a single instruction from the weighing equipment to terminate the fill or alternatively may receive a signal to slow down to a lower speed for the final few moments of the fill and then receive a second signal in order to terminate the filling completely.

This alternative form of weight control may produce better accuracy in that the quantity in suspension at the point of cut-off is less.

A signal instructing the stepping-motor 4 to reduce to a lower speed can be either from the weighing equipment or alternatively be on some other basis such as a lapsed time or number of revolutions of the stepping-motor.

CLAIMS

1. Apparatus for dispensing flowable materials comprising hopper means for containing material to be dispensed, dispensing means for positively dispensing the material from the hopper, characterised in the provision of stepping-motor means for controlling operation of said dispensing means.

2. Apparatus as claimed in Claim 1 including a mass flowrate sensor adapted to sense either the flowrate of material being dispensed or the total mass dispensed in a given dispensed dose and providing a signal respectively representative thereof, said sensor being coupled to said stepping-motor means for controlling operation thereof in response to said representative signals in order either to control the speed of said stepping-motor means and maintain a constant mass flowrate of dispensed material or to stop the stepping-motor means when a required mass has been dispensed, respectively.

3. Apparatus as claimed in claim 1 including weight-sensing means for sensing when a correct weight of material has been dispensed, said weighing means being adapted to provide a signal responsive thereto to stop said stepping-motor means.

4. Apparatus as claimed in claim 3 wherein said weighing means is a weighing scale or load cell.

5. A method of dispensing predetermined doses of flowable material employing dispensing means operable by a stepping-motor means and comprising the steps of accelerating said stepping-motor means and maintaining said means at a first predetermined speed through a first predetermined time interval until a first relatively high percentage of a total desired dose has been dispensed, decelerating said stepping-motor means and maintaining said stepping-motor means at a second predetermined speed through a second predetermined time interval until a second percentage of said desired dose has been dispensed, and bringing said stepping-motor means to rest through a third predetermined time interval, said second percentage being so related to said rate of deceleration that said dispensing means will have dispensed said required dose when said stepping-motor means has been brough to rest after said third predetermined time interval.

6. A method as claimed in claim 5 wherein the first and second time intervals are determined by a total mass sensor which is adapted to provide a response to control the speed of said stepping-motor means when the first and second percentages of a total required dose have been dispensed, respectively.

7. Apparatus for dispensing flowable material substantially as hereinbefore described and illustrated with reference to the drawings.

8. A method of dispensing predetermined doses of flowable material substantially as hereinbefore described.

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